

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

no action

Date: December 1, 1977

Project Title: Special Software for the Markamatic System

Project No: E-27-661

Project Director: Dr. L. Konopasek

Sponsor: CAMSCO, Incorporated

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Co

Agreement Period: From 9/1/77 Until 12/31/78
10/1/78

Type Agreement: Standard Industrial Research Agreement, dated 11/10/77

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Reports Required: Monthly Progress Reports

Sponsor Contact Person (s):

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Contractual Matters
(thru OCA)

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Defense Priority Rating: n/a

Assigned to: Textile Engineering (School/Laboratory)

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GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT TERMINATION

Date: 9/11/80

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Project Director: Dr. M. Konopasek

Sponsor: CAMSCO. Incorporated

Effective Termination Date: 12/31/79

Clearance of Accounting Charges: 12/31/79

Grant/Contract Closeout Actions Remaining:

- ☒ Final Invoice and Closing Documents
- ☐ Final Fiscal Report
- ☐ Final Report of Inventions
- ☐ Govt. Property Inventory & Related Certificate
- ☐ Classified Material Certificate
- ☐ Other _____

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Prepared with the support of
Camsco, Inc.
Richardson, Texas 75080

Special Software for the
Markamatic System

Final Report
by
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Atlanta, Georgia 30332

May 1980

CURRENT ISSUES IN CUT ORDER PLANNING

General

The cut order planning in the broadest sense means the schedulling (in time and space) of the events necessary for converting the flow of piecegoods coming from a supplier or warehouse into the flow of cut panels for further processing in the sewing department.

In the narrowest sense the cut order planning is equivalenced to breaking down cutting orders (i.e. quantities of garments of a certain style by sizes and colors) into numbers of plies of fabrics with a particular size distribution.

Thu fully-automatic and optimum cut order planning is not attainable because it would imply as one of the components a fully automatic generation of optimum markers which, in turn, is infeasible proposition at this time. On the other hand, exclusive computerisation of the cut order planning in the above defined narrow sense (or so called lay planning) would not bring a full benefit to Camsco and its customers.

A workable compromise between infeasible total solution and easy but superficial partial solution may be obtained by the conceptual integration of cut order planning, marker planning and marking.

In my opinion this proposition fits well the Camsco business objectives and Camsco customers' interests: I estimate that the number of markers made by Camsco customers should increase about ten times in order to tap such additional sources of material savings in apparel industry as pattern engineering, better size combinations, better marker design, fabric width management etc.

The pressure for more marking will generate higher demand for marking capacity and, consequently, additional sales of Markamatic systems.

There are two key issues in this development:

1. Improved operational characteristics of the Markamatic system and partial automation of marking should increase the operator's and system's productivity 4-5 times so that tenfold increase in marking would require only doubling of the equipment and marking cost.
2. The widening of the scope of the cut order planning will generate real need to experiment with the markers and to substantiate the COP decisions by an abundance of markers.

Past experience

The first version of the Markamatic cut order planning implied already a link between marking and lay planning. Beside the selection of an optimum set of existing markers to cover a part of the cutting order, a few other COP functions were computerized (a crude marker-bank retrieval system, close-to-optimum cutting table allocation, step spreading).

However, the COP-I was not truly interactive and there was no direct access to the markamatic data base. The use of the COP-I remained limited although according to a few users' claims it facilitates material savings.

Improved version of COP-I capable of dealing with large problems (more markers and sizes) in shorter CPU time available since the end of 1978 has not been yet fully implemented in the Markamatic environment.

The step spreading algorithm developed in 1979 aimed at customers with smaller cutting orders was not implemented. Consequently its generalization for rainbow spreading was also delayed.

More comprehensive COP systems announced and discussed at various occasions by KSA and HUGHES have not materialized.

The COP systems demonstrated at IMB show by Bergman & Johanson, Boras, Sweden, or marketed by this company on behalf of Gartech represents, in essence, microcomputer implementations of some trivial lay-planning functions. I believe in and I have been, for some time, a proponent of the use of similar approach to computerization of selected clerical functions. The idea is to let the computer generate hundreds of alternatives to an allocation problem (instead of no more than one or two generated by the clerk) and to let the clerk or the computer or both select the one fitting the best the local constraints and objectives.

I would not recommend this approach or the Gartech version as the only one (or as the leading one) for Camsco or Markamatic COP. The reasons:

1. Lack of linkage to the Markamatic data base.
2. Diversity of types and modifications of the allocation problems in the real world COP situations.

F u t u r e

1. Built the components of the Markamatic COP around the Markamatic marker retrieval system. (user interface package)
2. Implement the costing of the COP decision - similar to that provided by Gartech, but somewhat refined.
3. Provide the facilities for keeping track and taking advantage of the COP history.

May 1980

Milos Konopasek

"Magic number" allocation procedure

The algorithm (see program STEPl) goes through the following stages:

1. Reading in number of sizes NS , number of units by sizes NU_i , maximum number of bundles in a marker MNB , magic number MN .
2. Calculation of the unit fraction UFR and size-fractions rounded off to integers $KFR_i = LFR_i$ (for instance, in 100% if $MN=100$).
3. Scaling down the LFR_i through their division by a factor ML chosen so that the number of bundles NB is less or equal to MNB .
3. Evaluation of a number of layers NL , number of bundles by sizes MFR_i and a remnant of the order LFR_i . Printing the marker composition MFR_i for the particular step.
5. Repeating the steps 3. and 4. until the sum of LFR_i becomes 0.
6. Printing the summary of the step spread.


```

PROGRAM STEP1(INPUT,OUTPUT)
DIMENSION NU(10),KFR(10),LFR(10),MFR(10),MFRT(10)
READ *,NS,(NU(I),I=1,NS)
NUT=0
DO 1 I=1,NS
1 NUT=NUT+NU(I)
  READ *,MNB
5  READ *,MN
  IF (MN.EQ.0) STOP
  UFR=FLOAT(NUT)/FLOAT(MN)
  DO 10 I=1,NS
    KFR(I)=IFIX(FLOAT(NU(I))/UFR+.5)
    LFR(I)=KFR(I)
10 MFRT(I)=0
20 LFRT=0
  DO 21 I=1,NS
21 LFRT=LFRT+LFR(I)
    IF (LFRT.EQ.0) GO TO 50
    ML=MAX0(1,LFRT/MNB/2)
25 NB=0
    DO 26 I=1,NS
26 NB=NB+LFR(I)/ML
      IF (NB.LE.MNB) GO TO 30
      ML=ML+1
      GO TO 25
30 NL=IFIX(UFR*FLOAT(ML)+.5)
    IF (NL.EQ.0) GO TO 50
    DO 31 I=1,NS
      MFR(I)=LFR(I)/ML
      LFR(I)=LFR(I)-ML*MFR(I)
31 MFRT(I)=MFRT(I)+MFR(I)*NL
    PRINT 102,NL,NB,(MFR(I),I=1,NS)
    GO TO 20
50 PRINT *, " "
    KUT=0
    DO 55 I=1,NS
      KUT=KUT+MFRT(I)
55 PRINT 101,I,NU(I),MFRT(I),MFRT(I)-NU(I),
      & 100.*FLOAT(MFRT(I)-NU(I))/FLOAT(NU(I))
    PRINT 101,0,NUT,KUT,KUT-NUT,100.*FLOAT(KUT-NUT)/FLOAT(NUT)
    PRINT *, " "
    GO TO 5
101 FORMAT (4I6,F8.2)
102 FORMAT (2I4," ***",10I2)
END

```

LGO

? 8,123,264,345,725,563,586,478,325

? 12

? 100

205	12	***	0	1	1	3	2	2	2	1
102	6	***	1	0	1	1	1	1	0	1
34	11	***	1	2	1	0	2	2	2	1

1	123	136	13	10.57
2	264	273	9	3.41
3	345	341	-4	-1.16
4	725	717	-8	-1.10
5	563	580	17	3.02
6	586	580	-6	-1.02
7	478	478	0	0.00
8	325	341	16	4.92
0	3409	3446	37	1.09

? 200

205	12	***	0	1	1	3	2	2	2	1
68	10	***	1	0	2	1	2	2	1	1
34	5	***	1	1	0	1	0	1	0	1
17	5	***	1	1	0	1	1	0	0	1

1	123	119	-4	-3.25
2	264	256	-8	-3.03
3	345	341	-4	-1.16
4	725	734	9	1.24
5	563	563	0	0.00
6	586	580	-6	-1.02
7	478	478	0	0.00
8	325	324	-1	-.31
0	3409	3395	-14	-.41

? 500

198	12	***	0	1	1	3	2	2	2	1
68	11	***	1	1	2	1	2	2	1	1
20	11	***	2	0	0	3	1	2	0	3
7	10	***	2	0	2	0	2	2	2	0

1	123	122	-1	-.81
2	264	266	2	.76
3	345	348	3	.87
4	725	722	-3	-.41
5	563	566	3	.53
6	586	586	0	0.00
7	478	478	0	0.00
8	325	326	1	.31
0	3409	3414	5	.15

? 0

.168 CP SECONDS EXECUTION TIME.

/

Program STEP3

the program STEP3 extends the powers of the "magic number" allocation procedure by generating a set of solutions satisfying given cut order within specified tolerances.

The tolerances may be defined to constrain

LND - maximum negative difference in %
LPD - maximum positive difference in %
TOD - total difference in %
SAD - total absolute difference in %
SSD - standard deviation of differences.

The program STEP3 operates in two modes:

1. It scans through series of magic numbers MN from MNA through MNZ with an increment INC; whenever the solution falls within given tolerance, the solution summary, i.e.
magic number MN
number of steps NST
number of bundles NBT
total difference between the order and solution DIF
the LND, LPD, TOD, SAD, SSD
and the average size in the solution SID
are printed.
2. It accepts a particular magic number MN and it prints the marker composition for each step and the detailed solution summary.

```

PROGRAM STEP3(INPUT,OUTPUT)
DIMENSION NU(10),KFR(10),LFR(10),MFR(10),MFRT(10),
C      V(6),TGT(7),NM(10)
DATA NM/"LND","LPD","TOD","SAD","SSD","SID","AVS",
C      "ALL","LST","END"/,TGT/-100.,5*100.,0./
PRINT *, "NS,NU",
READ *,NS,(NU(I),I=1,NS)
NUT=0
DO 5 I=1,NS
5 NUT=NUT+NU(I)
PRINT *, "ALL",
READ *,K
IF (K.EQ.0) GO TO 2
1 PRINT *, "LIMITS",
READ *,(TGT(I),I=1,6)
IF (J.EQ.7) GO TO 110
2 PRINT *, "BDS,MNA,MNZ,INC",
READ *,MNB,MNA,MNZ,INC
3 KHD=0
DO 100 MN=MNA,MNZ,INC
NST=0
NBT=0
V(6)=0.
UFR=FLOAT(NUT)/FLOAT(MN)
DO 10 I=1,NS
KFR(I)=IFIX(FLOAT(NU(I))/UFR+.5)
LFR(I)=KFR(I)
10 MFRT(I)=0
20 LFRT=0
DO 21 I=1,NS
21 LFRT=LFRT+LFR(I)
IF (LFRT.EQ.0) GO TO 50
ML=MAX0(1,LFRT/MNB/2)
25 NB=0
DO 26 I=1,NS
26 NB=NB+LFR(I)/ML
IF (NB.LE.MNB) GO TO 30
ML=ML+1
GO TO 25
30 NL=IFIX(UFR*FLOAT(ML)+.5)
IF (NL.EQ.0) GO TO 50
MUS=0
DO 31 I=1,NS
MFR(I)=LFR(I)/ML
LFR(I)=LFR(I)-ML*MFR(I)
MUS=MUS+I*MFR(I)
31 MFRT(I)=MFRT(I)+MFR(I)*NL
NBT=NBT+NB
AVS=FLOAT(MUS)/FLOAT(NB)
V(6)=V(6)+ABS(AVS-TGT(7))*FLOAT(NB*NL)
IF (MNA.EQ.MNZ) PRINT 102,NL,NB,AVS,(MFR(I),I=1,NS)
NST=NST+1
GO TO 20
50 IF (MNA.NE.MNZ) GO TO 60
PRINT *, " "
KUT=0

```

```

DO 55 I=1,NS
KUT=KUT+MFRT(I)
55 PRINT 101,I,NU(I),MFRT(I),MFRT(I)-NU(I),
      100.*FLOAT(MFRT(I)-NU(I))/FLOAT(NU(I))
      PRINT 101,0,NUT,KUT,KUT-NUT,100.*FLOAT(KUT-NUT)/FLOAT(NUT)
      GO TO 110
60 KUT=0
DO 61 I=1,5
61 V(I)=0.
DO 65 I=1,NS
D=FLOAT(MFRT(I)-NU(I))
V(4)=V(4)+ABS(D)
V(5)=V(5)+(D/FLOAT(NU(I)))*2
KUT=KUT+MFRT(I)
P=100.*D/FLOAT(NU(I))
V(1)=AMIN1(V(1),P)
65 V(2)=AMAX1(V(2),P)
V(3)=100.*FLOAT(KUT-NUT)/FLOAT(NUT)
V(4)=100.*V(4)/FLOAT(KUT)
V(5)=100.*SQRT(V(5)/FLOAT(NS))
V(6)=V(6)/FLOAT(KUT)
IF (V(1).LT.TGT(1)) GO TO 100
DO 70 I=2,6
70 IF (V(I).GT.TGT(I)) GO TO 100
IF (KHD.EQ.0) PRINT 106,(NM(I),I=1,6)
KHD=1
PRINT 103,MN,NST,NBT,KUT-NUT,V
100 CONTINUE
110 PRINT *, " "
PRINT *, "KEY",
READ *,KEY
PRINT *, " "
IF (KEY) 2,300,120
120 MNA=KEY
MNZ=KEY
GO TO 3
300 PRINT *, "LIMIT",
READ 104,NAME
DO 310 J=1,10
IF (NAME.EQ.NM(J)) GO TO 320
310 CONTINUE
GO TO 300
320 IF (J.GT.7) GO TO 330
PRINT *, " ",
READ *,TGT(J)
GO TO 110
330 IF (J-9) 1,340,400
340 PRINT 105,(NM(I),TGT(I),I=1,6)
GO TO 110
400 STOP
101 FORMAT (4I6,F8.2)
102 FORMAT (2I4,F7.2," ***",10I2)
103 FORMAT (I5,I4,2I5,6F7.2)
104 FORMAT (A3)
105 FORMAT (4X,A3,F7.2)
106 FORMAT ("/" MN NST NBT DIF " ,6(A3,4X)/

```

C-----")

END

FTN, I=STEP3, L=0

1.904 CP SECONDS COMPILATION TIME

L60

NS, NU? 8, 140, 230, 250, 320, 320, 260, 120, 100

BDS, MNA, MNZ, INC? 12, 100, 1000, 100

MN	NST	NBT	DIF	LND	LPD	TDD	SAD	SSD	SID
100	3	23	-14	-2.40	5.00	-1.80	1.74	2.32	4.29
200	3	32	0	-4.00	1.67	0.00	1.03	1.73	4.27
300	3	36	0	-1.00	1.67	0.00	.57	.83	4.27
400	4	35	2	-1.00	1.67	.11	.57	.83	4.27
500	4	40	-4	-1.67	0.00	-1.23	.23	.66	4.27
600	4	40	-6	-1.00	.33	-1.34	.46	.60	4.27
700	4	45	-16	-3.00	0.00	-1.92	.93	1.42	4.26
800	5	44	2	-.71	.77	.11	.23	.40	4.27
900	4	48	0	-.71	1.00	0.00	.34	.50	4.27
1000	5	44	-1	-1.00	.31	-1.06	.29	.48	4.27

KEY? 0

LIMIT? SAD
? .2

KEY? 0

LIMIT? LND
? -.4

KEY? 0

LIMIT? LPD
? .4

KEY? -1

BDS, MNA, MNZ, INC? 12, 100, 1000, 1

MN	NST	NBT	DIF	LND	LPD	TDD	SAD	SSD	SID
174	3	30	0	0.00	0.00	0.00	0.00	0.00	4.27
347	3	36	0	0.00	0.00	0.00	0.00	0.00	4.27
348	3	36	0	0.00	0.00	0.00	0.00	0.00	4.27
349	3	36	0	0.00	0.00	0.00	0.00	0.00	4.27
821	5	42	0	0.00	0.00	0.00	0.00	0.00	4.27
822	5	42	0	0.00	0.00	0.00	0.00	0.00	4.27
868	5	42	0	0.00	0.00	0.00	0.00	0.00	4.27
869	5	42	0	0.00	0.00	0.00	0.00	0.00	4.27
870	5	42	0	0.00	0.00	0.00	0.00	0.00	4.27
871	5	42	0	0.00	0.00	0.00	0.00	0.00	4.27
872	5	42	0	0.00	0.00	0.00	0.00	0.00	4.27

KEY? 174

110	12	4.00	◆◆◆	1	2	2	2	2	2	1	0
30	12	5.08	◆◆◆	1	0	1	3	3	1	0	3
10	6	5.33	◆◆◆	0	1	0	1	1	1	1	1

1	140	140	0	0.00
2	230	230	0	0.00
3	250	250	0	0.00
4	320	320	0	0.00
5	320	320	0	0.00
6	260	260	0	0.00
7	120	120	0	0.00
8	100	100	0	0.00
0	1740	1740	0	0.00

KEY? 347

110	12	4.00	◆◆◆	1	2	2	2	2	2	1	0
30	12	5.08	◆◆◆	1	0	1	3	3	1	0	3
5	12	5.33	◆◆◆	0	2	0	2	2	2	2	2

1	140	140	0	0.00
2	230	230	0	0.00
3	250	250	0	0.00
4	320	320	0	0.00
5	320	320	0	0.00
6	260	260	0	0.00
7	120	120	0	0.00
8	100	100	0	0.00
0	1740	1740	0	0.00

KEY? 821

108	12	4.00	◆◆◆	1	2	2	2	2	2	1	0
28	12	5.08	◆◆◆	1	0	1	3	3	1	0	3
8	10	5.50	◆◆◆	0	1	0	2	2	2	1	2
4	6	3.67	◆◆◆	1	1	1	1	1	0	1	0
2	2	2.50	◆◆◆	0	1	1	0	0	0	0	0

1	140	140	0	0.00
2	230	230	0	0.00
3	250	250	0	0.00
4	320	320	0	0.00
5	320	320	0	0.00
6	260	260	0	0.00
7	120	120	0	0.00
8	100	100	0	0.00
0	1740	1740	0	0.00

KEY? 0

LIMIT? END

5.187 CP SECONDS EXECUTION TIME.

LGO
 NS,NU? 8,123,264,345,725,563,586,478,325
 ALL? 1
 LIMITS ? -.5,.5,.1,.1,100,100
 BDS,MNA,MNZ,INC? 12,100,500,1

KEY? -1

BDS,MNA,MNZ,INC? 12,501,1000,1

MN	NST	NBT	DIF	LND	LPD	TOD	SAD	SSD	SID
877	5	41	1	-.17	.29	.03	.09	.13	4.95
878	5	41	1	-.17	.29	.03	.09	.13	4.95
879	5	41	1	-.17	.29	.03	.09	.13	4.95
880	5	41	1	-.17	.29	.03	.09	.13	4.95
889	5	46	1	-.14	.31	.03	.09	.14	4.95
890	5	46	1	-.14	.31	.03	.09	.14	4.95
891	5	46	1	-.14	.31	.03	.09	.14	4.95

KEY? 877

198	12	5.08	***	0	1	1	3	2	2	2	1
66	12	4.50	***	1	1	2	2	2	2	1	1
19	10	5.00	***	3	0	0	0	1	3	0	3
8	6	5.00	***	0	0	2	0	2	0	2	0
4	1	8.00	***	0	0	0	0	0	0	0	1

1	123	123	0	0.00
2	264	264	0	0.00
3	345	346	1	.29
4	725	726	1	.14
5	563	563	0	0.00
6	586	585	-1	-.17
7	478	478	0	0.00
8	325	325	0	0.00
0	3409	3410	1	.03

KEY? 889

199	12	5.08	***	0	1	1	3	2	2	2	1
65	11	4.55	***	1	1	2	1	2	2	1	1
23	9	4.78	***	2	0	0	2	1	2	0	2
8	11	5.09	***	1	0	2	2	1	1	2	2
4	3	4.00	***	1	0	0	0	1	1	0	0

1	123	123	0	0.00
2	264	264	0	0.00
3	345	345	0	0.00
4	725	724	-1	-.14
5	563	563	0	0.00
6	586	586	0	0.00
7	478	479	1	.21
8	325	326	1	.31
0	3409	3410	1	.03

KEY? 0

LIMIT? END

5.369 CP SECONDS EXECUTION TIME.